

AGRICULTURAL RESEARCH FOR RESOURCE POOR FARMERS:

A PARSIMONIOUS PARADIGM

by

Robert Chambers and Janice Jiggins

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The greatest challenge now facing agricultural science is not how to increase production overall but how to enable resource-poor farmers to produce more.

With the transfer-of-technology (TOT) model of agricultural research - part of the normal professionalism of agricultural scientists - scientists largely determine research priorities, develop technologies in controlled conditions, and then hand them over to large agricultural extension to transfer to farmers. Although strong interests sustain this model, many now recognise its bad fit with the needs of hundreds of millions of resource-poor farm (RPF) families. In response to this problem, the TOT model has been adapted and extended through multi-disciplinary farming systems research (FSR) and on-farm trials. These responses retain power in the hands of scientists.

In contrast, the farmer-first-and-last (FFL) model transfers initiative to farmers, especially RPFs. The authors argue that FFL fits the diverse and complex conditions and needs of RPFs better than TOT, and makes more sparing and cost-effective use of scarce scientists. A parsimonious form of FFL avoids multidisciplinary teams and much data gathering and analysis by trusting farmers' knowledge and self-interest, and encouraging and enabling them to identify priorities for research.

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Although revisions have been made in the lights of comments received, responsibility for the views expressed is ours alone.

Abbreviations

BARI	Bangladesh Agricultural Research Institute
CIMMYT	International Centre for Maize and Wheat, Mexico
CIP	The International Potato Centre, Peru
E	Environment
FFL	Farmer-first-and-last
FSR	Farming Systems Research
G	Genotype
IARC	International Agricultural Research Centre
ICRISAT	International Crops Research Centre for the Semi-Arid Tropics, Hyderabad, India
ISNAR	International Service for National Agricultural Research, The Hague, Netherlands
ITK	Indigenous Technical Knowledge
NGO	Non-Government Organisation.
RPF	Resource-poor farm or farmer
RRA	Rapid rural appraisal
RRF	Resource-rich farm or farmer
TOT	Transfer-of-technology
T and V	The Training and Visit System for agricultural extension.

AGRICULTURAL RESEARCH FOR RESOURCE-POOR FARMERS: A PARSIMONIOUS PARADIGM

The Problem

Agricultural research has a good record with resource-rich farmers (RRFs). Rates of return to successful agricultural research are exceptionally high where the beneficiaries are the better-off. Increases of productivity per unit land have been dramatic in North America, Western Europe, and in a few well-endowed Third World areas like the Indian Punjab, and have been concentrated where farmers have relatively uniform environments, effective access to and control over inputs, and well developed infrastructure.

Agricultural scientists serve RRFs effectively for many reasons. Environmentally, the physical and access conditions under which RRFs farm are similar to those of the research station so that what works well there will usually work well with them. Many RRFs are concentrated in 'core' areas of high potential such as the alluvial plains and deltas of South and South-east Asia where both physical conditions such as soils, and social and cultural conditions, are relatively uniform (Rambo and Sajise, 1985) so that successful innovations tend to be widely applicable and easily disseminated. Politically, RRFs are articulate and influential, and whether they grow food crops for the market or industrial crops, they have effective lobbies and often funds to influence or sponsor research. Socially, they share class and professional attitudes and values with agricultural scientists, with whom they quite readily interact. Methodologically, normal agricultural science is reductionist, excelling in exploring the relationships of a restricted number of variables in controlled conditions. This suits it to large-scale simplified farming in which the natural environment is highly controlled, with monocropping and standardised mechanical, fertiliser and pesticide treatments.

For reasons, thus, which are environmental, political, social and methodological, much agricultural science serves the needs and capacities of the rich and less-poor.

In contrast, normal agricultural research has a bad record with resource-poor farmers (RPFs).^{1/} Part of the failure of agricultural extension with RPFs stems from the lack of messages which fit their objectives and conditions. One benefit from T and V has been to reveal the paucity of good, adoptable advice for extensionists to pass on to farmers, especially RPFs. This has pointed straight to the poverty and irrelevance of much agricultural research.

For this there are also many reasons. The conditions of RPF farming differ from those of RRFs and those of research stations. Environmentally, RPFs have less control over physical conditions (less flat land, less irrigation), less

access to inputs (draught power, fertilisers, pesticides, improved seeds), different priorities (family food first - crops for sale second, and risk reduction), often farming with more complex interactions (shifting cultivation, agro-forestry, intercropping, with multiple animal-crop-tree relations and sequences), and multiple household enterprises. In contrast with the relatively uniform conditions of core areas, the hinterlands in which many RPFs are found are highly diverse geomorphologically, ecologically and culturally, demanding highly differentiated and locale-specific research. Politically, RPFs are relatively unorganised and powerless, and lack resources to sponsor official and commercial research, or effective lobbies to influence it.^{2/} And socially, scientists with a different class, professional and sometimes cultural background also find them difficult or uncongenial to interact with.

Less well recognised are the methodological biases against RPFs. Scientific methodology is sometimes thought to be clinically impartial, but the reductionism which enables agricultural research to serve the simplified farming systems of RPFs at the same time has difficulty coming to terms with and serving the interactive complexity of many RPF farming systems. Further, the core methodologies of agricultural science pay more attention to plant materials (genotypes = G) and to physical and climatic components, and less to management aspects of the environment (E) and interactive (GE) effects (Simmonds 1981). One example of such GE effects is the ability of Hopi Indian maize to withstand deep planting to avoid dessication in low rainfall conditions. Another is the potential of maize and bean seeds, selected by farmers for their compatibility for planting in the same hole, but which scientists are liable to grow as monocrops. Moreover, restrictive definitions of 'environment' which minimise the influence of people in shaping GE interactions, are likely to be more damaging the greater the difference between RPF conditions and those found and created on research stations.

For reasons, thus, which again are environmental, political, social and methodological, most agricultural science has a bad record in serving farm families who are resource-poor. At the same time, the priority of enabling resource-poor farmers in less developed countries to do better has never been recognised more than now. The famines in sub-Saharan Africa have shown the terrible effects of downward spirals in which a lack of innovation for sustainable agriculture for RPFs is a factor. More generally, the traditional negative critique of the green revolution - that the rich got richer and the poor got much less, or stayed where they were - has pointed to the social importance in terms of equity of spreading benefits more widely. India's strategy of concentrating on well-endowed districts with good infrastructure and irrigation paid off in food production, but highlighted the stark contrast with smaller, poorer farmers, and less well endowed

districts with less irrigation, worse soils, some undulating land, and greater reliance on rainfall.

More crucially, perhaps, the priority of production *per se* as the means to alleviate poverty is now questioned as the costs of marginalisation become more evident. Outside parts of sub-Saharan Africa and perhaps of the sub-Andean countries, aggregate food availability is not a constraint. China, which suffered one of the worst famines of human history around 1960, is in food surplus. India is embarrassed by a large foodgrain buffer stock which it is feared may rise to over 40 mn tons in the next five years (EPW 1985). North America and Western Europe are dumping some of their vast surpluses on the world market. The problem of poverty is not a problem of production; it is a problem of who produces, who commands food, and who can afford to buy food and other basic goods. Hundreds of millions of the poorest people are members of resource-poor farming families. For them, it is a problem of their own production, both for self-provisioning and for sale. To serve them is now agricultural research's greatest challenge.

This paper argues that to meet that challenge requires a change in how scientists go about their work. It requires a different paradigm for agricultural research methodology. There have been several statements and many initiatives in this direction.^{3/} But they have almost always been extensions and modifications of the familiar model, which can be described as transfer of technology (TOT), rather than whole-hearted adoption of the paradigm described as Farmer-First-and-Last (FFL). In an earlier paper (Chambers and Gildyal, 1985), parts of the FFL model were outlined. In this paper we identify and elaborate what now appear critical and decisive elements to complete and reinforce it. To understand the rationale for this, we will first examine the normal professionalism of agricultural scientists, its attempts to meet the challenge of serving RPFs, and the reasons for its lack of success.

Normal Professionalism and the Transfer of Technology Model

Normal professionalism comprises the problems, values, methods and behaviours dominant in a profession, discipline or science. It derives from and is reinforced by a combination of training, rewards, tools, resources and location. Normal professionalism is a widespread phenomenon. Whether in medicine, engineering, economics, physics or the agricultural sciences, to name but some, it exhibits common characteristics: training and orientation in universities; research located in central places and conducted under controlled conditions; values set on accurate measurement and statistical rigour; preferences for whatever is capital-intensive, marketed, modern, and 'sophisticated'; social biases towards working with and for the rich rather than with and for the poor; belief in a sequential logic of

cause and effect; and difficulty perceiving the value-content of its own 'objective' methodologies. Normal professionalism is sustained by belief in the superiority of scientific method and of modern knowledge as these are taught, learned and disseminated.

Within industrial practice, a distinction is made between the normal professionalism of output-oriented science and client-oriented technology development. In industry, client-oriented professionals are educated and trained to a much greater degree for market research and user-participation in research, and use methods which encourage professional responsiveness to user concerns. Agricultural science, in contrast, is output-oriented rather than client-oriented; scientists develop the product and extension has to sell it. In most cases, extension does not provide adequate feedback to agricultural research concerning RPF's priorities and innovations.

The normal professionalism of agricultural science is linked with the Transfer-of-Technology (TOT) model (Chambers and Gildyal, 1985). In this model, pressure groups and scientists determine research priorities, and then scientists design experiments, conduct these under controlled conditions on experiment stations, in laboratories and in greenhouses, and hand over the results (varieties, treatments, and so on) to commercial interests and extension organisations for adaption and transfer to estates and to farmers.

Agricultural scientists are conditioned by training and motivated by pressures and incentives to work within and to support the TOT model. Four forces operate to maintain and reinforce it: education and training; government and commercial funding and influences; research methodology; and professional and personal rewards and incentives.

First, education and training are shaped in the TOT model. The hierarchical learning of school and university implants the idea of learning from above and teaching to below. Agricultural science syllabuses are concerned with scientific detail and scientific research methodology, not with technology development or how to learn from farmers. Farming systems research is rarely taught and anyway, as we argue below, is tending to turn itself into a variant of the TOT model. By the time they leave universities, scientists have been deeply conditioned to believe that they know more than farmers, that their knowledge is superior, and that they should be the people who determine what research should be done and how it should be conducted.

In practice, though, broad research priorities are often determined by a second force - government and commercial funding and influences. These give priority to industrial crops and to marketed food crops. Industrial crop research is funded by both governments and commercial organisations, as is

research on chemical fertilisers and pesticides. Food crop research is predominantly for crops which are marketed, whether for government procurement for buffer stocks, for subsidised food for urban markets and the poor, or for export. A production orientation directs attention to regions well endowed with natural resources (irrigation, rainfall, good soils) and to resource-rich farmers who can most readily produce an easily assembled marketed surplus. Strong demands are made on researchers by various organised groups: primary producers organised in farmer associations; fully or semi-mechanised primary processors; intermediate users who further transform the product in a variety of industrial processes; commercial input suppliers; and consumers who have a voice through political channels or through organised consumer lobbies. Each is capable in some degree of expressing its requirements and, through political or financial leverage, influencing breeding criteria and research programming. This 'market' typically is integrated, interactive and fairly stable over time and location and reinforces the TOT model because, by and large, TOT research is effective in meeting the needs of the interests it comprises.

The third force is research methodology. The methods of the TOT model are relatively straightforward and well understood. They simplify farming complexities to study only a few variables at a time. These methods fit and reinforce the industrial and marketed food crop and resource-rich farmer biases because estates and larger farmers tend to have simplified cropping patterns. Research on fertiliser response and pesticide applications follow set routines. The reductionism of normal professional agricultural research fits the simplifications of commercial farming.

Fourth, professional and personal rewards and incentives strengthen support for the TOT model. The mark of excellence is output, not service. Agricultural scientists are rewarded for their publications, and their work is accepted for publication in journals whose editors require, or are believed to require, the application of normal professional methods. Reductionist research, with few variables, produces more papers than research with more variance among more variables and more complex interactions. Direct financial incentives also draw scientists to work on industrial crops or food crops of major marketing importance, or to work on chemical inputs. Personal convenience, and preferences for clients of their own class also incline scientists in that direction. And finally, there is the profoundly gratifying belief that the scientist knows best and that his (most scientists are men) knowledge is powerful and superior. It is this superior knowledge, developed by scientists, which is then in the TOT model to be transferred to farmers.

This analysis does not imply wholesale condemnation of present scientific endeavour or of individual scientists. What it does

show is that normal professionalism and the TOT model are intimately and powerfully linked.

TOT and Resource-Poor Farmers

In practice, the technology generated by normal professionalism and the TOT model fits badly the needs and priorities of resource-poor farmers. This is for the obverse of the same four reasons given above.

First, though changes are slowly occurring, agricultural syllabuses users and textbooks are still biased towards techniques and strategies which are capital-intensive, large-scale, high-input, and market-oriented.

Second, resource-poor farmers are not an organised or stable 'market'. They are scattered, control few formal organisations and are not able to make their needs and priorities readily known and felt. Most of the primary processing and intermediate transformation is carried out by primary producers and food consumers themselves close to the point of production, using domestic or only partially industrialised technologies which are locale-specific. RPFs form in fact, a variety of 'markets', each with its own characteristics, potentials and requirements. Within the TOT model and the existing organisation of agricultural research, few channels exist either for researchers to investigate these markets or for producers and consumers to signal them.

Further, for commercial estates and resource-rich farmers, breeders are not required to take up the full burden of adjustment by developing varieties which maintain yield in unfavourable climatic conditions: a shortfall in output is adjusted by financial and trade mechanisms, and producers are well-enough off to be buffered against the shock. With RPFs, in contrast, and in regions with poorly developed product markets, such financial and trade mechanisms do not quickly adjust for yield fluctuations. This is not only because they are poorly developed or badly managed at the regional, national or sub-national levels; it is also because they do not reach into the domestic economy of the poor households where so much of the production, processing and consumption take place.

Third, reductionist research methodology cannot easily handle the complex interactions of RPF farming: links between crops, especially with intercropping and multiple tiers; agroforestry and livestock-crop-tree complementarities; creation and exploitation of microclimates; and the progressive adjustments required in the field in the face of seasonal and inter-annual fluctuations.

Fourth, personal and professional incentives to work on subsistence crops, or small stock, or with RPFs, are weak. Crops have their own status ranking, and those associated with

subsistence and only localised marketing are at the bottom. An ambitious scientist will not choose to work on, say, shade tolerant native vegetable species.

These four influences explain why so much of the work of scientists is irrelevant to RPFs. But there are also other reasons why the technologies produced by the TOT model are inappropriate for RPFs. These are presented in Tables 1 and 2 which contrast physical, social and economic conditions on research stations, on commercial estates and RRF farms, and on RPF farms.

Historical Explanations for Non-adoption and Research Responses

The frequent failure of RPFs to adopt the technologies developed by agricultural scientists has been met with a historical sequence of explanations and research responses.

The first was to attribute non-adoption to farmers' ignorance and psychological outlook. This diagnosis, so prevalent in the 1950s and 1960s, spawned a host of diffusion of technology studies which assumed that the technology was good, and sought to explain adoption and non-adoption in terms of farmers' personal characteristics. The prescription was to improve and intensify extension services to overcome the ignorance and the resistance of the non-adopters.

A second response was to change the agenda of research, towards the crops and conditions of the resource-poor. Attention to root crops like cassava by the International Agricultural Research Centres is one example. Another is the creation of a whole institution, ICRISAT, with a mandate for a difficult environment (the semi-arid tropics) and neglected poor people's crops (sorghum, the millets, chick-pea and pigeon pea).

However, neither the criteria on which farmers choose to grow particular varieties of 'poor men's crops' nor the end uses for which selection was made, appeared on the agenda.

A third response, recognising the complexity of small farming systems and their many internal biological interactions, was to modify research designs. Some were large and complicated, both on-station and in scientists' experiments on (RRF) farmers' fields. At CATIE in Costa Rica, agricultural research had been fundamentally oriented by commodity or by discipline or by both. But in 1973 a 5 ha central experiment was implemented. This comprised various alternative production systems, with 216 cropping configurations arranged in 54 cropping patterns (Paez et al., 1984). Elsewhere, methods of on-station research were invented to throw light on key questions and relationships for difficult physical and climatic environments. Intercropping research 'increased dramatically' (Mead and Stern 1980:329) in the 1970s. Modern

TABLE 1: TYPICAL CONTRASTS IN PHYSICAL CONDITIONS

	Research experiment station	Resource-rich farm (RRF)	Resource-poor farm (RPF)
Topography	flat or some-times terraced	flat or some-times terraced	often undulating and sloping
Soils	deep, fertile, few constraints	deep, fertile, few constraints	shallow, infertile, often severe constraints
Macro and micro-nutrient deficiency	rare, remediable	occasional	quite common
Plot size and shape	large, square	large	small, irregular
Hazards	nil or few	few, usually controllable	more common - floods, droughts, animals grazing crops, etc.
Irrigation	usually available	often available	often non-existent
Size of management unit	large, contiguous	large or medium, contiguous	small, often scattered and fragmented
Natural Vegetation	eliminated	eliminated or highly controlled	used or controlled at microlevel

Adapted from Chambers and Ghildyal, 1985:6

TABLE 2: TYPICAL CONTRASTS IN SOCIAL AND ECONOMIC CONDITIONS

	Research experiment station	RRF family	RPF family
Access to seeds, fertilisers, pesticides and other purchased inputs	unlimited, reliable	high, reliable	low, unreliable
Source of seeds	foundation stocks, and breeders' seed high quality	purchased high quality	own seeds
Access to credit when needed	unlimited	good access	poor access and seasonal shortage of cash when most needed
Irrigation, where facilities exist	fully controlled by research station	controlled by farmers or by others on whom s/he can rely	controlled by others, less reliable
Labour	unlimited, no constraint	hired, few constraints	family, constraining at seasonal peaks
Prices	irrelevant	lower than RPF for inputs higher than RPF for outputs	higher than RPF for inputs lower than RPF for outputs
Priority for food production	neutral	low	high
Access to extension services	good but one-sided	good, almost all material designed for this category	poor access; little relevant material

Adapted from Chambers and Ghildyal, 1985:7

statistical techniques and ingenious combinations of physical layouts have countered some of the more serious methodological difficulties. Progress has also been made with the evaluation and presentation of the advantages of intercropping to include not just increases in biological efficiency but also the advantages likely to be obtained by farmers (Willey 1985).

A fourth response was to analyse farm-level constraints which might account for gaps between the yield in research station conditions and yield on farmers' fields. Although 'constraints research' generated valuable insights, the typical recommendations to which it gave rise were to change farmers' conditions to make them more like those of the research station and especially to improve access to inputs including water. As post facto analysis of dynamic situations, it was better at identifying past constraints than at generating specific guidelines for future breeding programmes.

These four responses are all within the TOT model. Blaming farmers is a negative defence, denying any need to change the research process. Changing the crops researched, and changing research design and methods on research stations, both tackle defects but leave the basic TOT structure unaltered. Constraints research directs attention more to changing the farm environment than to changing the research paradigm.

TOT Adapted: Farming Systems Research

A fifth response, farming systems research (FSR) does in its approach and concepts look rather different from the TOT model. It tries systematically to understand the complexity of total farming systems. These include the farm household and its needs and objectives, and biological, economic and human dimensions. Different observers have identified different activities and stages in FSR. Shaner, Philipp and Schmehl (1982) have:

diagnosis - trial design - experimentation - verification
- extension

Maxwell (1986:66) has five different steps:

classify - diagnose - recommend - implement - evaluate

Both these sources, and many others, see FSR as a logical sequential process concerned with the whole farming system including the farm household. Most FSR entails on-farm trials as a stage in the testing and modification of recommended practices.

FSR is an important adaptation of the TOT model. Its objectives differ from straight disciplinary and commodity research; it encompasses benefits to the farm family through an understanding of its farming system; and the location of

some of the work differs, being on-farm instead of on-station. But the power of choice, in practice (so far) mostly remains with scientists: information is extracted from the farmers and their farms and analysed by scientists, in a manner which enables the scientists to diagnose and prescribe for the farmers. Even if farmers' diagnosis of problems is one of the starting points, the diagnosis is translated into terms testable by scientists and the solutions are derived from scientists' knowledge systems. The key decisions about what to try and what to do remain with the scientists.

FSR, in its many forms, has made a major contribution to understanding small farming systems, and to improving agricultural research. To generalise about its weaknesses is to select aspects which are not necessarily universal. Exceptions can be found. Nevertheless, five weaknesses are commonly found which suggest that it is not a final answer.

First, multidisciplinary collaboration between various sorts of agricultural scientists and social scientists has proved problematic. Modern FSR as a research paradigm within anglophone traditions is largely a social scientists' invention and has been seen by agricultural scientists as a threat to the independence of their decision-making. How to maintain good relations in a team and work together constructively has been a preoccupation of many who have practised multidisciplinary FSR.

Second, the volume of data to be collected and its analysis and use, perhaps as a consequence of FSR's historical evolution through farm management economics, has proved unwieldy. Biological scientists can become frustrated with the 'endless process' of socio-economic data collection (Galt 1985a:11). A vast amount of data can be called for in any comprehensive attempt to understand a farming system. A persuasive case can be made for taking account of linkages, such as those between health, nutrition and agriculture (Maxwell 1984b), but every new consideration adds to data requirements, processing and analysis, however logical and necessary its inclusion appears.

Attempts to overcome these two weaknesses have varied. They include sophisticated computer modelling of crop-soil-water interdependencies. Several fall under the rubric of rapid rural appraisal (RRA) (Agricultural Administration 1981; Longhurst 1981, Galt 1985b). Multidisciplinary data integration can be improved by working in pairs under time pressure, as in Hildebrand's one-week investigation known as a Sondeo (Hildebrand 1981). Data collection can be restrained through informal semi-structured guided interviews (Collinson 1981: Grandstaff and Grandstaff 1985b). But the action and power are retained in 'our' knowledge system. Collaboration between outsiders - members of the team - receives more attention than their collaboration with insiders - the farmers. Knowledge is extracted so that it can be used and

the results then transferred back again. The knowledge system model is still TOT.

Third, FSR's typical lack of explicit focus on resource-poor farmers perpetuates some elements of RRF bias. Many forces direct FSR towards RRFs: funding for research on cash crops; class affinities; convenience of access; ease of communication; the greater readiness of better-off farmers to accept the risks of on-farm research; and even the moral considerations that it would be unfair to inflict the hazards of on-farm research on an RPF. It is rare to find priority to RPFs advocated or described in the FSR literature.^{4/} On the contrary, the point is sometimes made that better-off farmers will be better informants and better collaborators: far from offsetting the biases towards RRFs, advantages are seen in working with them. Where on-farm research procedures give attention to the recruitment of collaborators, they tend to push researchers toward farmers who are around the socio-economic mean on the presumption that these represent the most effective target category for diffusion. By definition, these are farmers with resources deemed sufficient by researchers to cope with the technology under trial. Beyond this, in practice biases of class and convenience can be expected to exert an upward bias. Yet RPF conditions tend to be very different from those of RRFs.

Fourth, the preparation of scientists for face-to-face dialogue with farmers has received little attention.^{5/} Just as management in an organisation is often thought to be an innate skill which need not be learnt, so interacting with farmers is not a subject generally considered worth teaching. In consequence, even with FSR, there is a danger of researchers adopting superior attitudes, lecturing to farmers instead of learning from them, and failing to understand more than the obvious and observable aspects of a farming system. Unless a deliberate effort is made, agricultural scientists, with their preference for the visual and substantial, are liable to undervalue or overlook aspects of farming systems which may be critical but small in cash value or volume, or which cannot be seen. Examples include seasonal changes, prices, interannual fluctuations, intra-household relations, labour peaks, rents, and debts. Moreover, causal linkages cannot be adequately explained without investigation of farmers' rationality, yet scientists based in commodity or disciplinary programmes typically display impatience with investigation of farmers' system constructs. Nor do they readily admit the need to make apparent to farmers the assumptions on which their own mental constructs are based, if a balanced dialogue is to take place.

Fifth, there are difficulties communicating the knowledge gathered by FSR-based scientists to their colleagues in commodity and disciplinary programmes. The idea that FSR insights should determine research agendas is resisted; and in practice the gap may widen between agricultural scientists'

control over research programming in basic and applied science and FSR-based scientists who are relegated to an adaptive role.

Perhaps the greatest single extension of the TOT model has been on-farm trials (OFT) and research conducted within a system perspective.^{6/} On-farm trials began as transfers to farmers' fields of experiments which otherwise would have been conducted on research stations. FSR has added a system orientation. OFTs subject plant materials at a somewhat earlier stage than classical TOT to some of the stresses found in 'agricultural reality'. But researchers still manage most of the trials. More recently, some pioneers in on-farm trials have transferred more control and discretion to farmers. In the form which has gone furthest (Ashby 1984), farmers themselves manage the trials and decide non-trial management practices, and even exercise some influences on research priorities; but this is still exceptional. Some approaches which tend in these directions are described nowadays as 'participatory research', but this title can mislead. The model usually remains TOT, with few concessions to farmers' own experimental capacities and paradigms, and with the determination of what is to be tested and how it is to be tested and evaluated still in the hands of the scientists.

Closing the Circle: Whose Priorities?

Although recently there have been efforts to modify the organisation of research and normal professionalism, almost all aim to do so primarily by bridging the gaps within the TOT model, either between research and extension, or between extension and resource-poor farmers, or by direct scientist-farmer interaction. While the linear sequence has been modified by building in 'feedback loops' and iterative cycles of referral and evaluation, the determination of priorities, diagnosis, evaluation and prescription remain in the control of scientists.

Viewed as a knowledge system, the paradigm remains a centre-periphery model; knowledge production is centralised and hence knowledge has to be translated and diffused to the users on the periphery.

This is so even in most FSR practice. The rhetoric has changed, and even sounds radical. But most FSR writing stops short of categorical statements that farmers, let alone RPFs, should themselves be enabled to determine what research priorities should be.^{7/} The furthest that authors usually go is to argue for 'equality' between an FSR team and farmer colleagues with little guidance on how that equality is to be achieved. In practice, capacity to contribute to the key decisions about what problems research should investigate tends to remain in the hands of the outsiders, the agricultural and social scientists of the FSR team and their research station colleagues.^{8/}

How could it be otherwise? It seems an unalterable assumption among most researchers that 'broadly speaking, the demand for agricultural research can hardly be expected to originate with small farmers' (Luning 1982:38). As the following three examples illustrate, even leaning strongly in the direction of farmer involvement in decision-making does not necessarily entail the institutionalisation of procedures which enable RPFs to articulate their priorities and then make those the research agenda.

Richard Harwood's excellent book *Small Farm Development* (1979:37) was a landmark publication in its advocacy of involving farmers in research. Harwood urged that: 'The farmer must be part of the research team, involved in making plans and decisions at all levels and stages and sharing credit for results' (ibid:36). He emphasises the need for the development specialist to guard against the natural tendency to superimpose his own values on those of the farmer, and the importance of understanding farmers' goals. On-farm research starts with selection of the target area by scientists and then description of the area. The design of alternative technologies follows, where 'Working closely with the selected farmers, the scientists plan what tests can be done to accomplish specified mutual goals with the available resources' (ibid:38).

Experiments are then jointly planned by scientists and farmers. The approach, Harwood's 'new kind of research', makes many reversals, and would still appear exceptional to many agricultural scientists. But it does not take the final, and in our view crucial, step of explicitly enabling farmers themselves to identify what they want from scientists.

Another example which comes close to FFL without going the whole way is Jacques Faye's report (1980) on the Land-Tenure Systems Program in Senegal. The title of his article sounds firmly FFL: 'Farmer Participation and Accounting for the Needs of the Most Disadvantaged Groups: some ideas on participation at the outset of a research program'. Several phrases suggest that initiative was encouraged from the most disadvantaged, for example: 'one of the tasks is to help the groups whose living conditions the project aims to improve by putting them in a situation where they develop their own strategies to modify their social status' '...we deliberately created a situation for a dialogue with the farmers so that they could express their opinions spontaneously...' (ibid: 123).

But these are isolated observations in a text predominantly in the TOT mode. A project concerned with an entire rural population, we are told, should start with an analysis of social stratification, and needs and priorities related to different groups.

Once this analysis has been carried out and we have identified the poorest categories ... we can build a

program and determine the objectives for meeting their needs. This condition appears to be a necessary one if farmers are to participate in the project and not be passive towards it. Participation is not an abstract notion, it is the adherence, the collaboration of groups whose needs the project aims to satisfy (ibid:122).

The team would continue only if farmers approved and consented, but it is outsiders - 'we' - who conduct the analysis, identify the poorest, and build the programme and proposals for the next phase. The relationship with farmers is reflected in a statement that a number of influential farmers could after a time be relied on to relay proposals or to make counterproposals. Countenancing counterproposals goes further than much present FSR practice. But it does not go the whole way.

A final example is the edited papers of the workshop held at Ouagadougou in September 1983 on farmers' participation in the development and evaluation of technology (Matlon et al 1984). The publication, from which we have borrowed the heading of this section of the paper, is entitled Coming Full Circle: farmers' participation in the development of technology. The approaches reported range from TOT modified by FSR (e.g. Prakah-Asante et al), to something very close to FFL (Rhoades 1984). Some authors advocate that farmers should be members of an FSR team (Rhoades:148; Kirkby and Matlon:160). In their conclusions, Kirkby and Matlon make several recommendations to shift initiative towards farmers: that farmers' language and units of measurement should be used by researchers; that technology should meet farmers' perceived problems; that farmers should be encouraged to think of experiments as their own; and that they should be allowed to modify experiments. They point out that farmers can help select technology worth testing by indicating specific technical problems and pre-screening technologies for feasibility. They note that farmers can assist actively in the analysis of their farming systems, and that group discussions and other techniques in which the researcher is primarily an observer warrant further attention and scrutiny. All this goes a long way. Only one element seems missing: a decisive and categorical specification of a process which encourages and enables resource-poor farmers to indicate what they need and want.

A Parsimonious Paradigm

In an earlier paper a Farmer-First-and-Last (FFL) model for agricultural research for RPFs was outlined. This differed from TOT in involving reversals of normal professional tendencies. It was described as starting:

not with scientists and their perceptions and priorities, but with RPF families and theirs. It begins with a systematic process of scientists learning from, and understanding, RPF families, their resources, needs

and problems. The main locus of research and learning is the resource-poor farm, rather than the research station and the laboratory. Research problems and priorities are identified by the needs and opportunities of the farm family rather than by the professional preferences of the scientist. The research station and the laboratory have a referral and consultancy role, secondary to, and serving, the RPF family. The criterion of excellence is not the rigour of on-station or in-laboratory research, or yields in research station or resource-rich farmer conditions, but the more rigorous test of whether new practices spread among the resource poor (Chambers and Gildyal, 1985:13).

Three main elements in the model are diagnosis, R and D on-farm and with-farmer, and evaluation by adoption. In the remainder of this paper we concentrate on diagnosis, while recognising that much development and analysis remains to be done with the other two.

The diagnostic part of the FFL model has been explored in different institutions and locations. These include CIMMYT's approach for planning technologies appropriate to farmers (Byerlee and Collinson 1980); Hildebrand's Sondeo, or rapid reconnaissance (Hildebrand 1981); ICRAF's diagnosis and design (D and D) (Raintree and Young 1983); and CIP's farmer-back-to-farmer (Rhoades and Booth 1982). All of these are being modified in the light of ongoing experience.

Farmer-back-to-farmer is closest to the new paradigm as we now wish to present it (see Rhoades and Booth, 1982, Rhoades n.d. and 1984, and Rhoades et al. 1985). The elaboration of the diagnostic part of FFL which follows draws on the experience gained by Booth, Horton, Rhoades, Werge and others at CIP, where farmer-back-to-farmer was developed, and builds on and elaborates the proposals put forward by Richards (1985) in Indigenous Agricultural Revolution.

The need for the FFL paradigm is acute. The RPF farming systems, especially those of the hinterlands, present an entirely new order of challenge to agricultural research for which the experience of research for the cores is misleading. The ecological and social complexity and diversity of RPF farming systems can only be covered through a new and strict parsimony of demands on research resources. This requires two simplifications:

i. to avoid large surveys and massive multidimensional data analysis: Large-scale surveys with long multidisciplinary questionnaires conform to normal professionalism but lead to normal error and normal impotence. Both the rationale and the practice of rapid rural appraisal (RRA) as an antidote to the pathology of conventional surveys have been described (see Carruthers and Chambers 1981; Gibbs 1975; Jamieson 1985; Grandstaff and Grandstaff 1985a). Approaches for

agricultural, farming systems, agroforestry, and agroecosystem research have been developed and described by Collinson (1981), Hildebrand (1981), Rhoades (1982), Raintree and Young (1983), Galt (1985a and b), Conway (1985a and b), and Anil K. Gupta and others in Bangladesh (personal communications). RRA more generally has been pioneered in several places, with the University of Khon Kaen in Thailand in the vanguard (Limpinuntana 1985; Samart 1985). RRA techniques are proving replicable and are increasingly accepted as respectable. They deserve careful scrutiny and inventive development as part of the new paradigm, since to be cost-effective and feasible it has to go quickly to the point.

ii. to reduce dependence on multidisciplinary teams: Social scientists in particular advocate multidisciplinary teams. Their desirability is now almost an article of faith. They have their virtues but also costs in mobilising the teams, managing their interactions, handling logistics, and report-writing. More seriously, they are not widely replicable. International Agricultural Research Centres themselves have their own form of high-level research station bias. They have the resources, flexibility and contacts to be able to hire agricultural economists and social anthropologists, and to field teams of social and agricultural scientists together. But this is more difficult to do in national systems. IARCs such as CIMMYT have made significant progress by supporting the building of FSR teams in national systems, but it is unrealistic to suppose that national multidisciplinary teams will be feasible on anything like an adequate scale in the foreseeable future. Most research stations will be without social scientists, or if they have them, will not be inclined or able to give them their head even if they are trained in FSR. Moreover, problems of transport, fuel and days out allowances have, in most countries made it harder for teams to get to the field. In practice a single scientist, or a pair, may manage to get out, using a small vehicle if they are lucky, or motorcycle, bicycle, or public transport, but a team of the size fielded by an IARC is usually out of the question. In any case, the principle of parsimony and replicability points to diagnosis by single or paired scientists; and since personal commitment and even sacrifice are involved, it may be at first only one or a pair who are prepared and able to act.

To make these two simplifications, the key step we propose is that the scientist or scientists should directly encourage and enable RPF families themselves to identify priority research issues. This is the crucial link to which the remainder of this paper is devoted. The case for this will be made on the basis that the priorities and experimental frontiers of RPF families and those of professional scientists are different. It is also based on respect for and confidence in the ability of RPF families to tell scientists their understanding of the problems they face, and to identify how the formal research system can help them. The central questions are whose

knowledge counts and how to get the best of both worlds - the knowledge and skills of the RPFs and those of the scientists. Our thesis is that reversals, with RPF families themselves enabled to discuss and identify their problems and priorities, can present a new parsimonious and replicable paradigm for agricultural research.

Resource-Poor Farm Families and Scientists: Whose Knowledge Counts?

The past decade has seen increasing recognition and documentation of the richness, validity and usefulness of the knowledge of rural people in general and of farmers in particular (e.g. Barker et al. 1977; IDS 1979; Brokensha et al 1980; Gilbert et al 1980: 14-15; Rhoades 1985; Richards 1985). This recognition has been strong in Latin America, Africa, and swidden farming areas of South-east Asia, though weaker in South Asia.

For this paper, it is unnecessary to recite the evidence.^{9/} The emergent consensus among those who have studied indigenous technical knowledge (ITK) as it has been called, is that its categories, constructs and content differ from those of modern science, are more closely linked to farming experience, and capture much that modern science misses. ITK provides a currency of terms and concepts which are often of more utility for RPF farming practice than those of scientists. One implication is that the most efficient formulation of problems and issues for research will take place within the medium of the language and concepts of farmers, rather than those of scientists. Farmers and their knowledge have four advantages over scientists and scientists' knowledge which are not often fully recognised.

The first is their knowledge of the whole farming system including interactive GE effects. Although this is recognised in principle, the extent and significance of the knowledge of the less directly agricultural aspects - access to inputs, risk, market relations, food processing, storage and use - is often undervalued by professionals. Farmers will almost always take a broader view of the implications of technical change than a scientist.

Second, studies of ITK show that climatic and physical factors do not determine what is grown; they only set limits to what is possible. And these limits are less determinate than many scientists assume and accept as RPFs manage to modify and exploit micro-environments and climates - adaptations which are hard to reproduce in on-station conditions.

Third, farming as an activity is highly time-driven. To maintain a livelihood in variable intra-annual and inter-annual environments and economic conditions, farmers have to innovate and adapt in order to survive. Agricultural

researchers come and go; farmers' knowledge provides a continuous stream of understanding and experience.

Fourth, there is the increasingly appreciated prevalence of experimentation by farmers. To most normal professionals, research and experimentation are activities conducted only by trained outsiders, on research stations, and not by farmers, on their fields. Richards (1985:156) remarks on '... the evident surprise of many agricultural researchers at the idea that smallholder farmers in Africa are active experimenters. "This cannot be so" (I have sometimes been told) "because the men and women concerned are illiterate."'

Yet 'informal R and D' is not only widespread but necessary for farmers to survive, adapting to new and variable conditions (Biggs 1980; Biggs and Clay 1981). Many observers (e.g. Johnson 1972; Brammer 1980; Ashby 1984) have remarked on its prevalence and effectiveness. In one sense, farmers are continuously experimenting and learning, in that they rarely repeat exactly what they have done before, and conditions continuously vary. More directly, it is common for farmers to be interested in new crops and new varieties and enthusiastic about trying them out systematically. Home gardens are often sites for such trials, undertaken with low risk because they are on a small scale (Ninez 1984: 9-10). Farmers are also reported to experiment with controls. Not only may they have little difficulty in understanding the concept of a control; they may already be familiar with it (Ashby 1984: 20).

Many scientists, however, find it hard to recognise and respect - let alone learn from - the experiments, experience and knowledge of farmers, and especially RPFs. Their professional training teaches them that farmers are by implication ignorant - 'by implication' because professional training imparts another structure of knowledge. Researchers are not taught how to learn from farmers. A working group 'preparing young professionals for agricultural research for development', in listing competencies required in young professionals, included understanding the special needs of resource-poor farmers but made no mention of learning from them; on the contrary, it listed 'ability to handle farming skills confidently in front of farmers' as desirable (IADS 1979: 80-81). But confident handling of farming skills in front of farmers is precisely part of the problem - an impediment to learning. Researchers are taught to teach, not to learn. When an attempt is made to get scientists to learn from farmers, difficulties arise. On a fertiliser trials project in Colombia, farmers were asked to teach the agronomist and sociologist their local techniques for planting and fertilising crops. Ashby (1984: 19) records that:

In a practical teaching situation, often in the fields with traditional tools, it is soon apparent how clumsy, slow-on-the-uptake, and inexpert researchers can be in terms of the farmers' traditional technology. The

agronomist, trained to instruct farmers, suffered in this situation: his automatic reaction as an expert, was to argue with farmers and point out how things should be done.

Outsider experts often adopt a superior, lecturing mode and find fault with whatever a farmer is doing. They get away with this partly because, as Ashby has pointed out, 'farmers will seldom openly disagree with researchers' (1984:15).

Scientists project 'first' values - industrial, capital-intensive, dependent on cash inputs - into 'last' environments - impoverished, labour-intensive, dependent on local inputs - where they often make no sense or are otherwise unadoptable by RPFs. A rice scientist interpreting for a visitor in a meeting with an RPF, asked the farmer not the question the visitor asked - whether he had used farmyard manure - but whether he had used urea - the recommended practice, and the practice on the research station.¹⁰ Farmers' behaviour is interpreted negatively: when farmers experiment with low fertiliser applications to find out what works and pays best for their conditions, they are seen not as experimenters but as deviants who do not adopt recommended practices.

The seriousness of this scientific disability is evident from the common difference between scientists' and farmers', let alone RPFs', ideas of priorities and the consequent irrelevance, or danger of irrelevance, of much agricultural research. Three examples yield important lessons.

The first example is cotton research in Northern Nigeria. For 20 years, research station work was based on planting cotton at the time when yields would be highest, that is, when the rains came. The practices recommended were scarcely adopted, except by a few subsidised resource-rich farmers, because farmers would only plant cotton after they had their food crops in the ground. It was only when a social scientist conducted surveys and investigations from a systems perspective with agricultural scientists that it came to be recognised by the scientists that research station experiments should follow farmers' practice of planting cotton late, even though yields would be lower. After the change, one of the scientists said: 'I wasted 20 years of my life.'

The second example concerns potato storage in Peru (Rhoades and Booth 1982; Rhoades n.d.; Rhoades et al 1985). For 25 years scientists' storage research was based on the assumption that losses in storage were a problem for farmers. When a sustained effort was made to find out farmers' views:

... it became clear that scientists and farmers perceived the storage problem differently. When the post-harvest team asked farmers about storage 'losses', farmers responded they had no 'losses'. Farmers claimed that

potatoes that shrank or suffered insect attack were simply selected out and fed to pigs. These potatoes, already the poorest of the harvest, were considered necessary as feed for their livestock. Additionally, some wives claimed that small, shrivelled potatoes tasted sweeter and were sometimes desired for their culinary quality (Rhoades et al. 1985).

Farmers did, however, have a problem. The high-yielding varieties adopted over the previous decade sprouted and lost weight in storage, besides requiring work to pull off sprouts at planting time. But the scientists had an answer to this: diffused light inhibits sprouting. The resulting programme enabled farm families to apply the diffused light principle, each adapting its resources and materials in its own way. The programme has spread rapidly in at least 21 countries.

The third example comes from on-farm trials for fertiliser applications to beans in Colombia (Ashby 1984). Agricultural scientists proposed on-farm trials to test yield responses to different doses of phosphate. When farmers were carefully consulted, however, it turned out that they were interested in testing mixtures of phosphate with their traditional fertiliser, chicken manure, which was becoming more expensive. Soil scientists who developed the design preferred not to test with mixtures including organic fertilisers because of the difficulties of controlling and interpreting nutrient responses from different sources (Ashby 1984:45). In the end, both the scientists' trials with phosphate alone, and the farmers' desired trials with mixtures were carried out.

The lessons of these three examples are striking. In all three cases farmers had knowledge which scientists lacked, and knew their own priorities; in all three cases, farmers' priorities differed from those of scientists; and in all three cases, scientists were slow or reluctant to find out about and accept farmers' priorities. The outcome of the phosphate-chicken manure trials is not known, but in the two earlier cases, scientists' work could become relevant and begin to have an impact once they abandoned their priorities and adopted those of farmers. The lesson can be generalised: that scientists should find out and act on farmers' priority problems as they, the farmers, perceive them.

Practical Needs and Options

For scientists to enable RPFs to discuss and articulate their problems and priorities requires face-to-face learning at the outset of research programming. There is no substitute for this. The old prescription of feedback of farmers' problems through extension has not worked well, and prevents the clarifying dialogue in which scientist and farmers can match their different systems of knowledge and find out how to get the best of both. The direct meeting is the crux, the occasion and process on which attention must be focussed.

The highest priority is for scientists - agricultural and social - to gather together well-established experience, to test new techniques, and thus to build and disseminate a systematic methodology. This in turn requires changes on the part of journal editors. If they are serious about agricultural research for resource-poor farmers, then journals like Experimental Agriculture and Tropical Agriculture should solicit and publish accounts of experiences of consulting and working with RPFs just as they publish accounts of methodologies for scientific experimentation; indeed since this is a more open and unexplored methodological frontier, it deserves priority.

Developed and tested methods are needed for many activities. Of these we select four for discussion here: training scientists in reversals of attitudes and demeanour; identifying and working with RPF families; consulting farmer groups and panels; and organising innovator workshops. In this paper we do not discuss joint experimentation with farmers through on-farm and with-farmer R and D, vital though these are as a next stage and also as a learning process for scientists.

training scientists in reversals

It is a major reversal for scientists to flip from believing, as they have been taught, that their knowledge is superior and RPFs are ignorant, to recognising their own areas of ignorance and being willing, even eager, to learn from RPFs. The force of example and training through apprenticeship can be effective for this sort of change but is bound to be limited in scale. Larger-scale techniques need to be developed and used. Options include role-playing with role reversals, field placements and exercises, videos and video playbacks, and simulation games. One of the best replicable approaches may be rapid rural appraisals (RRAs) as practised by the Faculty of Agriculture and now other Faculties at Khon Kaen University in Thailand. The Khon Kaen experience has been that changes of attitude follow from RRAs conducted in small teams; a scientist with extensive RRA experience was willing to confess at length to a conference about the many mistakes he had made in failing to learn from farmers, being misled, being the victim of biases, and so on, demonstrating the self-critical awareness that is required. But such changes do not come easily. Promising initiatives in Bangladesh, encouraging scientists to do case studies of poor farmers' practices and to learn from them, faced initial resistance to selecting poor farmers and going to them without a questionnaire (Gupta 1986). Unless widespread changes of attitude and demeanour occur and can be expressed with undefended openness, face-to-face learning from farmers and a learning dialogue with them will not be well achieved. Power and status are sharply polarised between scientists and poor farmers, so farmers have to be encouraged and enabled to interview

scientists and pick their brains. For that, scientists have to develop humility, empathy, respect, patience and skills, to encourage those who defer and keep quiet to speak out.

Some of the experience of the IARCs might appear to suggest that scientists on their own are unlikely to be able to do this. The pioneering in the IARCs in learning from farmers and in FSR has been led by social scientists and agricultural researchers working outside official and commercial science. Quotations from biological scientists indicate that social scientists' contributions, perhaps especially their social anthropological approach, have helped them. One biological scientist at CIP said:

Getting us to really see the farmer's point of view is one hell of a contribution. We don't get hung up on the fact that anthropologists help link us with our clients ... Communication and understanding between scientists and farmers is an art requiring an expertise which alone many biological scientists don't have (Rhoades et al 1985:11).

The ideal may be to have a first class social anthropologist to help. The reality in national systems will almost always be that there is none available. Scientists must therefore be trained to be their own social anthropologists. How to learn from farmers must, then, be a prominent part of their training.

identifying and working with RPF families

Resource-rich farmer bias is a well-known weakness in rural contacts by agricultural and social scientists. If the farm families met are RRFs there is a danger that needs or constraints crucial for RPFs will be unwittingly screened out. Much of the FSR literature ignores this point. Where the bias is mentioned, advice on how to offset it tends to be geographical and to refer to domains defined by production 'problems' specified by researchers rather than types of farm families within a certain area. 'Resource-poor' is then defined by the soils-water-topography-vegetation environment rather than by farm size, farm labour or capital resources. The physical and biological environments are relevant and important but do not encompass the whole spectrum of resource-poverty. Using them to define resource-poverty neglects, to take one example, single-female-headed farm families who are now quite often over one third of the farm families in rural areas in sub-Saharan Africa. Even within resource-poor environments, some categorisation of the population is likely to be desirable, for not all RPFs are poor in the same way. Simple and quick techniques are needed for scientists to offset biases and, within homogeneous categories of RPFs, to find farm families who are willing and able to engage in discussion and dialogue.

Scientists increasingly work with farm families through on-farm research, but this tends to be with relatively resource-rich farmers. It may take longer for RPFs to understand what they can ask of scientists and what they cannot, and to derive a mutually satisfactory experimental design, but RPF farm families whom their peers regard as reliably experimental can be selected, and confidence and understanding built through repeat visits.

This is in line with the 'case study' approach advocated by Maxwell (1984a). The objective of this approach is not to produce a large amount of data for statistical analysis but rather to increase understanding of farmers' experimental frontiers and of the farm system. It reduces desk time and increases field time for principal researchers and requires and permits close contact between them and the farmers. All the same a case study as outlined by Maxwell requires a lot of data collection. Significantly, however, he observes that a case study programme 'begins to generate useful ideas very quickly after its initiation' and that 'informal data on management strategies can be of use in the short term'. That such quick results can have an impact on a research programme, as he suggests, adds credibility to our argument that scientists who build up relationships with individual RPF families should quite quickly be able to learn what research would help them.

farmer groups and panels

A greater potential probably lies with groups and panels. 'Groups' here refer to meetings on a one-off basis, and 'panels' to numbers of people who meet recurrently. Consultation with groups and panels does not fit normal agricultural professionalism. Even FSR methods are concerned with individual farmers and farms. Groups or panels are, to our knowledge, scarcely mentioned.^{12/} Several reasons can be suggested for this. It is easier and sometimes more orderly and focussed to meet a farmer or farm family than a group. Interviews with individual farmers conform to normal professionalism: surveys need statistics, and the normal way to collect statistics in the social sciences is through surveys with individual respondents. Moreover, since the FSR objective is for outsiders to gain a detailed enough understanding of the farming system for them to be able to prescribe, individual interviews, especially when semi-structured, have much to recommend them.

Whether farmers or outsiders are alone or in groups affects their behaviour and relations. The individual interview is attractive when outsiders come as a team. The more multidisciplinary FSR becomes, the more likely this is. One bad tendency, beautifully illustrated in a photograph by Rhoades (1982:16), is for the many outsiders to stand and talk to one another while the one farmer stands aside and watches,

alienated. With teams of outsiders, the balance of numbers shifts power and the centre of discussion in their favour. With farmer groups and panels, the balance of numbers shifts power and the centre of discussion towards them.

Groups and panels have disadvantages: one person may dominate; people may come and go; all may defer to one important person; no-one may wish to speak because the members have not discussed what party line to take; sensitive personal information cannot be sought or probed. But there are advantages too: more knowledge can be tapped, and cross-checking can be automatic if members correct each other. Groups and panels in such ways can be good sources of information, to be extracted by the outsider. The greatest advantage of a group can, however, come from its own internal discussion. This fits a strategy of outsiders enabling farmers to identify and specify their problems instead of extracting their knowledge in order to do it for them.

The experience of focus groups is relevant (SIFP 1981). These are convened for a free-ranging discussion of a topic. Focus groups have been used by commercial companies, and also for social action programmes (Schearer 1981) to elicit qualitative information, including attitudes. A recent example was a rapid study of reasons for the non-utilisation of public health facilities in Nigeria (Attah 1985). Each group is selected to be homogeneous within certain limits - for example, all men, or all women, or in our context it could be all RPFs with less than a certain acreage, or without irrigation. Groups usually have 6 to 12 members. A moderator has a discussion guide, but this is only an aide-memoire, and free and wide-ranging discussion is encouraged. A focus group usually lasts about two hours, but participants often want to go on for longer.

Focus group research to gain understanding of potential clients' attitudes to commercial products is well established in the West. For example, '... many companies have a full-time staff of moderators and facilities, including rooms with one-way mirrors, recording equipment, and video equipment. They also maintain a complete infrastructure for recruiting the necessary participants' (Folch-Lyon and Trost 1981: 448).

Commercial organisations recognise the importance of being close to their clients and understanding them well through listening to their group discussions. Necessarily, a great deal of attention is given to group selection and recruitment procedures.

The contrast with agricultural research for RPFs is sharp. That some form of focus groups are not an established part of agricultural research methodology in part reflects the lack of client orientation compared with commercial organisations which have to sell their products in order to survive. We

know of few examples of the systematic use of groups of farmers in diagnosis for agricultural research. One is night meetings with farmers in Bangladesh (Alam et al 1986). Another is the ad hoc special group approach used by the ICRAF (International Council for Research on Agroforestry) in its D and D (Diagnosis and Design) methodology. In a rapid appraisal to identify agroforestry potential in a hill area in North India, special groups from the same village met simultaneously with D and D team members to discuss particular problems: a women's group met with a woman member to consider women's problems; and other groups met for subjects such as tenure, and the use of trees on common and public land. In rapid rural appraisal generally, the use of groups has been neglected, but is receiving more attention.

Panels are also promising. Focus groups are normally one-off events. But for the identification of research issues and priorities, a recurrent and iterative process may be needed. There are instances of farmers being members of advisory boards, but they are usually RRFs and not RPFs, and the normal procedure is to ask them to comment on or endorse priorities and proposals which have already been worked out. Such panels are therefore usually sounding boards for what scientists have already decided they want to do. We have been able to find only two recent cases of RPF farmer panels being convened on a systematic basis to assist in the identification of agricultural research priorities (although consumer or tasting panels are less rare). In the first, researchers working on the Small Ruminant Collaborative Research Support Program in the Community of Aramachay in Peru from 1983, signed a joint agreement with the village assembly to work on production problems which the farmers themselves identified (Fernandez 1986). Within this framework, women sheep farmers organised themselves into the Women's Livestock and Crop Production Committee of Aramachay as a panel for ongoing diagnosis leading to experimentation and adaptive testing of fodder legumes on fallow lands under the women's management. In the second, farmer panels were initiated in 1985 in Botswana (personal communication, David Norman). An agricultural programme there at Mahalapye convened farmer panels to serve 'as a discussion forum for ideas about improving arable production', and to help implementation of a series of trials. Meetings were to take place with agricultural staff once a month and would, among other things, discuss alternatives to present farming methods. A circular about the programme stated that: 'In explaining these meetings, it is important the farmers understand this is a new approach to research in which we want to work together with them to discuss and evaluate alternatives, rather than just rely on collecting information from them.'

With such panels, much will depend on the selection and interest of the farmers, the style of meetings, and the relations with researchers. Within the group and panel format, techniques such as the Problem Census and Critical

Incident Technique (borrowed from planning, psychology and business practice) may have a role to play (Adams 1982; Flanagan 1954). Initiating, managing and learning from groups and panels to encourage and enable RPFs to think through and articulate their priorities for scientists' research is now a frontier in agricultural research methodology; and gaining and sharing experience is vital.

innovator workshops

Informal R and D by farmers is widespread and important but often ignored. Formal R and D can be oriented to complement this informal sector. Exploratory rural innovator surveys are useful to find out quickly when new practices are being tried out by farmers (Biggs 1980). Knowing these is likely immediately to suggest research priorities in the formal sector.

There are respects in which farmers' R and D has advantages over formal R and D. Farmers are often ahead of scientists where experimental flexibility is needed with multiple simultaneous 'best-bet' interventions. These tend to involve complex interactions of many variables over space and time: for example, seasonal land-shaping, manipulation of micro-environments and micro-climates, intercropping, crop-livestock interactions, multiple-tier cropping, agroforestry, and integrated fish culture. These are precisely spheres where conventional reductionist agricultural research methodology is at its weakest.

Farmers trying out a combination of new practices are often isolated from each other. To capitalise on their simultaneous innovation, they have to meet. Moreover they need to meet in conditions conducive to sharing experience, with time to discuss and to see things in the field. In an innovators' workshop, suitable farmers are first found, and then brought together to learn from each other, and to generate ideas for further trials and for supporting formal sector research. Scientists are in attendance to listen and learn, and where appropriate to contribute in an advisory capacity. Innovator workshops have been widely and successfully proven in a number of spheres outside agricultural research in recent years (ESCAP/FAO 1979).

An example of an agricultural innovators' workshop is a seminar convened by voluntary agencies and government in North-east Thailand in 1982. Twenty-nine farmers were found who had been trying out growing fish with rice in rainfed conditions (SATC 1983). They were brought together for three days. Scientists also attended, but were instructed to listen at first rather than talk. The farmers were so interested that they sat up until 2.00 a.m. on the first night. The report on the workshop said that

... the atmosphere was extremely open, friendly and exciting; both in the small groups (5-6 people) and in the big conference room, the farmers dared speak out very frankly. They did not worry whether what they said was right or wrong according to 'theory'. This was probably because of the way the meeting was structured to focus on personal experiences and sharing them (SATC 1983:14).

One problem with innovator workshops is a bias towards resource-rich farmers. Awareness of this bias, and attempts to offset it may be important. A judgement can be made whether the innovations are only likely to be adopted by resource-rich farmers before deciding to convene the workshop, and preference among invitees can be given to RPFs.

Conclusion

This paper has argued for a turn-around in agricultural research for resource-poor farmers. Parts of the farmer-first-and-last model have already been explored and developed in a number of places. The most highly developed cluster of activities is team appraisal; the next is participatory R and D and evaluation by farmers' adoption; and the least developed is enabling RPFs to identify research needs. Although it sounds straightforward for scientists to learn from farmers, and to convene groups or panels or innovator workshops, how to do this is rarely part of scientists' training, and good methods are anyway not well known. Nor has discussion of such methods penetrated the harder professional literature. A search of the past ten years of Experimental Agriculture has drawn a blank. Enabling farmers to say what they would like scientists to help them with is not yet part of normal professionalism.

Yet if our thesis is correct, FFL should enable scientists in national systems, given appropriate attitudes and skills, to serve RPFs more practically and cost-effectively. The last step or link in the FFL model, of handing initiative to farmers to do their own appraisal, is parsimonious, avoiding heavy survey and complicated analysis. It is the next logical step of simplification in rapid rural appraisal. It appears feasible even where scientists are few, or where only one or two want to explore the approach: by requiring the commitment of only one or two scientists, it offers scope for widespread adoption. It has the immense advantage of enabling national agricultural research systems better to adapt to and serve the great ecological, social and economic diversity of RPF farm conditions.

To make progress with the necessary reversals on anything like an adequate scale requires the development and sharing of methods and experience, and a radical change in the training, rewards and behaviour of agricultural scientists. The International Agricultural Research Centres should take a lead

in this, especially ISNAR, but their mandates discourage field-level methodological innovation with farm families or can be used as an excuse for avoiding it. Their scientists frequently do not speak local languages and so would be at a disadvantage in learning by listening to farmer panels. They may not be open to simple, cheap, and quick methods for identifying research and development priorities. More generally, institutional inertia coupled with belief in the superiority of modern science over farmers' knowledge, will deter scientists from adopting a parsimonious FFL approach which relies on farmers' identification of priorities.

Whether or not the IARCs take the lead, others need not wait. A few national scientists already convene and consult RPF farmer panels, and conduct exploratory investigations to determine the frontiers of farmers' informal R and D. There is little to prevent others, such as imaginative NGOs, in collaboration with government research agencies, convening innovator workshops. National scientists and NGOs who break the bounds of normal professionalism in these ways may not be rewarded in the short term as the weight of institutional process is against them; but in the long term they should find that they have been at the cutting edge of agricultural research and development.

AGRICULTURAL RESEARCH PARADIGMS

PARADIGM	IDENTIFICATION OF RESEARCH ISSUES AND PRIORITIES	ROLE OF AGRICULTURAL SCIENTISTS	ROLE OF SOCIAL SCIENTISTS	METHODOLOGICAL CONCERNS	MAJOR CRITERION FOR EVALUATION OF TECHNOLOGY	MAIN PROBLEM IS SEEN AS IGNORANCE OF	RELATED EXTENSION PHILOSOPHY
TOT	Traditional	By agricultural scientists	Expert determining resources priorities and developing new technology	Interpreter explaining farmer adoption/non-adoption	Correct use of normal scientific methods	Biological productivity	Farmers
	Much FSR	By social and agricultural scientists	Team Member: extracting, analysing and acting on FS information	Team Member: extracting, analysing and acting on FS information	Multi-disciplinary team management. Data analysis	Economic returns	Agricultural scientists and with
FFL		By RPF farm families	Consultant and colleague	Facilitator and moderator	Reversals RRA Enabling and learning from RPF families	Adoption by RPFs	Social scientists and agricultural scientists
							Do themselves

Notes

1. It is recognised that many RPFs use the resources available to them intensively and derive quantities of farm inputs from their environment or from recycled household or farm output. RPF is here used as a handy term for the characteristics summarised in Tables 1 and 2.
2. This is not to say that RPFs have no organisational means, such as plant material and seed exchange networks, for supporting their own experiments. Too little attention has been paid to these.
3. The contribution is recognised of agricultural missionaries, of francophone traditions and of the important work of some colonial researchers, in developing what is here described as a different paradigm. Many of its elements have been delineated and practised over the years but not, as far as we know, presented paradigmatically.
4. For a recent exception, perhaps the start of a trend, see Conway 1985b, who states (p.5) that the focus is on 'The problems, constraints and opportunities of the poor'.
5. But see Robert Rhoades (1982) the Art of the Informal Agricultural Survey for an exception.
6. On-farm trials have been widely practised for many years; and the basic notions of FSR have also been practised if not named in many, scattered, programmes. Social science research indicating the potential gains to breeding programmes of farmer innovations, experimental criteria, and uses of biomass, dates back many years. As examples among many, see the work of Y.P. Singh, Head Agricultural Extension Division, Indian Agricultural Research Institute, Delhi, in the mid 1960s, and more recently of A.K. Gupta of the Indian Institute of Management, Ahmedabad.
7. Curiously, and in contrast, Western European and American scientists are often comfortable with the idea that their own domestic clients should determine research agendas and station experiments. In the Netherlands, farmer determination of research on experiment farms, and farmers' close organisational and professional links with centres of basic science, are considered real strengths of the agricultural research system. The gap between the perception of 'farmers and farming' of scientists trained in normal professionalism, and the conditions of life of the majority of RPFs, might account for the blindness discussed here.
8. The restrictions which some scientists feel government policy places on their capacity to respond to (RPFs) local

priorities is recognised. However, as long as scientists lock themselves into a (TOT) research process which minimises their ability to refer information on relevant opportunities upwards, there is little prospect of them gaining greater room to manoeuvre for themselves.

9. The sceptical reader is referred to the sources above, and to the references in Brokensha et al 1980. Paul Richards' (1985) book Indigenous Agricultural Revolution is a powerful statement on this subject.
10. The farmer had not applied urea, but dutifully said he would if he could manage to get enough money. Subsequent questions revealed that he had, however, applied farmyard manure. As so often, an RPF's practices and those of the research stations were different in kind, because of constraints faced by the RPF and not by the research station.
11. Experimental Agriculture is, however, known to be seeking stronger social science contributions.
12. See, for example, Shaner et al. 1982: 73-83 on collecting primary data.

References

- Adams, M.E, 1982, Agricultural Extension in Developing Countries, Longman, Harlow
- Agricultural Administration 1981, 'Special Issue on Rapid Rural Appraisal', vol 8 no 6
- Alam, M.N. et al., 1986 'Reports on Impressionistic Profile Map of Tangail District and Farmers' Reaction in Night Village Meeting', manuscript, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur, Bangladesh
- Ashby, Jacqueline, 1984, 'Participation of Small Farmers in Technology Assessment', Report on a Special Project of the International Fertilizer Development Center (mimeo)
- Attah, E.B., 1985, 'Underutilization of Public Sector Health Facilities in Imo State, Nigeria: a study with focus groups', Final Report, April (mimeo)
- Barker, D., J. Oguntoyinbo and P. Richards, 1977, The Utility of the Nigerian Peasant Farmer's Knowledge in the Monitoring of Agricultural Resources: a General Report, MARC Report No 4, Chelsea College, London
- Biggs, Stephen, 1980, 'Informal R and D', Ceres 76, July-August, pp 23-6
- Biggs, Stephen and Edward J. Clay, 1981, 'Sources of Innovation in Agricultural Technology', World Development, vol 9 no 4 April, pp 321-36
- Brammer, Hugh, 1980, 'Some innovations don't wait for experts', Ceres, 132, March-April, pp 24-8
- Brokensha, David W., D.M.Warren and Oswald Werner (eds.), 1980, Indigenous Knowledge Systems and Development, University Press of America, Lanham
- Byerlee, Derek, and Michael Collinson, 1980, Planning technologies appropriate to farmers - concepts and procedures, CIMMYT, Mexico
- Chambers, Robert and Ian Carruthers, 1981, 'Rapid Rural Appraisal for Rural Development', Agricultural Administration vol 8 no 6 pp 407-22
- Chambers, Robert and B.P.Ghildyal, 1985, 'Agricultural Research for Resource-Poor-Farmers; the farmer-first-and-last model', Agricultural Administration, vol 20 no 1 pp 1-30
- Collinson, Michael, 1981, 'A low cost approach to understand small farmers', Agricultural Administration vol 8 no 6 pp 433-50

Conway, Gordon R., 1985a, 'Rapid Rural Appraisal and Agroecosystem Analysis: a case study from Northern Pakistan', in FA UKK, September

_____, 1985b, 'Rapid Rural Appraisal for Agroecosystem Analysis, Training Notes for the Aga Khan Rural Support Programme, Northern Pakistan', First Edition, September, Aga Khan Rural Support Programme, Gilgit, Northern Pakistan and Centre for Environmental Technology, Imperial College of Science and Technology, London

EPW, 1985, 'A Different Food Crisis', Editorial, Economic and Political Weekly (Bombay), 21 September

ESCAP/FAO 1979, Transfer of Knowledge and Skills Among Peer Groups: A Manual On Methodology, Bangkok

FA UKK, 1985, 'Papers of the International Conference on Rapid Rural Appraisal', Faculty of Agriculture, University of Khon Kaen, Thailand, 2-5 September

Faye, Jacques, 1980, 'Farmer Participation and Accounting for the Needs of the Most Disadvantaged Groups: some ideas on participation at the outset of a research program', in ICRISAT, Proceedings of the International Workshop in Socioeconomic Constraints to Development in Semi-Arid Tropical Agriculture, 19-23 February 1979, Hyderabad, India (available from ICRISAT, Patancheru, AP, India 502 324) pp 120-4

Fernandez, M.E., 1986, 'Technological Domains of Women in Mixed Farming Systems of Andean Peasant Communities', paper to Gender Issues in Farming Systems Research and Extension, Feb/Mar 1986, University of Florida, Gainesville

Flanagan, J.C., 1954, 'The Critical Incident Technique', Psychological Bulletin, vol 51 no 4 July, pp 327-58

Folch-Lyon, Evelyn and John F.Trost, 1981, 'Conducting Focus Group Sessions', Studies in Family Planning, vol 12 no 12 pp 443-9

Galt, D.L., 1985a, 'Farming Systems Research Based on True Interdisciplinary Interactions and Rapid, Responsive Diagnostic Inputs', draft, Supplementary Paper at the 2nd Annual South-east Asian University Agroecosystems Network meetings, Baguio, Philippines, March 18-22

_____, 1985b, 'How Rapid Rural Appraisal and Other Socio-economic Diagnostic Techniques Fit into the Cyclic FSR/E Process', in FA UKK

Gibbs, Christopher, 1985, 'Rapid Rural Appraisal: an Overview of Concepts and Application', in FA UKK

Gilbert, E.H., D.W.Norman and F.E.Winch, 1980, Farming Systems Research: A Critical Appraisal, MSU Rural Development papers No 6, Department of Agricultural Economics, Michigan State University, East Lansing, Michigan

Grandstaff, Terry B. and Somluckrat W. Grandstaff, 1985a 'A Conceptual Basis for Methodological Development in Rapid Rural Appraisal', in FA UKK

Grandstaff, Somluckrat W. and Terry B.Grandstaff, 1985b, 'Semi-Structured Interviewing', in FA UKK

Gupta, Anil K., 1986, 'Learning to Unlearn: checklist of questions to be pursued during the finalisation of the case studies of household decision-making', Bangladesh Agricultural Research Institute (mimeo)

Harwood, Richard R., 1979, Small Farm Development: Understanding and Improving Farming Systems in the Humid Tropics, Westview Press, Boulder (Co)

Hildebrand, Peter, 1981, 'Combining disciplines in rapid appraisal: the Sondeo approach', Agricultural Administration, vol 8 no 6 pp 423-32

IADS, 1979, Preparing Professional Staff for National Agricultural Research Programs, Report of a Workshop, Bellagio, Italy, February 16-21, 1979, International Agricultural Development Service, New York

IDS, 1979, 'Rural Development: Whose Knowledge Counts?', IDS Bulletin, vol 10 no 2, IDS, Sussex

IRRI, 1978, A Handbook on the Methodology for an Integrated Experiment on Rice Yield Constraints, International Rice Research Institute, Los Banos, Laguna, Philippines

Jamieson, Neil, 1985, 'The Paradigmatic Significance of Rapid Rural Appraisal', in FA UKK, September

Johnson, Allen W., 1972, 'Individuality and Experimentation in Traditional Agriculture', Human Ecology, vol 1 no 2, pp 149-59

Kirkby, Roger and Peter Matlon, 1984, 'Conclusions', in P. Matlon et al. (eds.), Coming Full Circle, pp 159-164

Limpinuntana, Viriya, 1985, 'Conceptual Tools for RRA in Agrarian Society' in FA KKU

Luning, H., 1982, 'Extension and Relative Advantage in Rural Development' in G.E.Jones and M.Rolls (eds.), Progress in

Rural Extension and Community Development, Vol I, John Wiley, New York

Longhurst, Richard, 1981, 'Rapid Rural Appraisal', IDS Bulletin vol 12 no 4, IDS, Sussex

Matlon, Peter, Ronald Cantrell, David King and Michel Benoit-Cattin, 1984, Coming Full Circle: Farmers' Participation in the Development of Technology, International Development Research Centre, Ottawa

Maxwell, Simon 1984a 'The Role of Case Studies in Farming Systems Research', in Discussion Paper 198, IDS, Sussex, November

_____, 1984b, 'Health, Nutrition and Agriculture: linkages in farming systems research', in Discussion Paper 198, IDS, Sussex, November

_____, 1984c, 'The Social Scientist in Farming Systems Research', in Discussion Paper 199, IDS, Sussex, November

_____, 1986 'Farming Systems Research: hitting a moving target', World Development vol 14 no 1 pp 65-77

Mead, R. and R.D. Stern, 1980, 'Designing Experiments for Intercropping Research', Experimental Agriculture, vol 16, pp. 329-42

Ninez, U., 1984, 'Household Gardens: theoretical considerations of an old survival strategy', Food Systems Research Report 1 CIP, Lima, Peru

Paez, G., L.A.Navarro, C.F.Burgos, J.L.Saunders and J.Arzo, 1984, 'Concepts and Implementation of Farming Systems Research at CATIE', in ISNAR Issues in Organization and Management of Research with a Farming Systems Perspective Aimed at Technology Generation, Proceedings of a Workshop, International Service for National Agricultural Research, The Hague, pp 21-8

Raintree, J.B. and A.Young, 1983, 'Guidelines for agroforestry diagnosis and design', ICRAF Working Paper No.6, International Council for Research in Agroforestry, Nairobi, November

Rambo, A. Terry and Percy E. Sajise, 1985, 'Developing a Regional Network for Interdisciplinary Research on Rural Ecology: the Southeast Asian Universities Agroecosystem Network (SUAN) Experience', Environmental Professional 7

Rhoades, Robert E., 1982, The art of the informal agricultural survey, Social Science Department Training Document 1982-2, International Potato Center, Lima, March

_____, n.d., 'Three Models of the Development and Generation of Acceptable Agricultural Technology', International Potato Center, Lima (mimeo)

_____, 1984, 'Tecnicista versus campesinista: praxis and theory of farmer involvement in agricultural research', in Matlon et al Coming Full Circle, pp 139-50

_____, 1985, Traditional potato production and farmers' selection of varieties in eastern Nepal, Potatoes in Food Systems Research Series Report No. 2, International Potato Center, Lima, Peru

_____, and Robert H.Booth 1982, 'Farmer-Back-to-Farmer: a Model for Generating Acceptable Agricultural Technology', Agricultural Administration, 11, pp 127-37

_____, Ponciano Batugal and Robert H.Booth 1985, 'Turning Conventional Agricultural Research and Development on Its Head: the Farmer-Back-to-Farmer Approach', ASPAC Extension Bulletin 223, Food and Fertilizer Technology Center, Taipei City, Taiwan, pp.23-37

_____, Robert Booth, Roy Shaw and Robert Werge, 1985, 'The Role of Anthropologists in Developing Improved Technologies', Appropriate Technology vol 11 no 4, March, pp 11-13

Richards, Paul, 1985, Indigenous Agricultural Revolution: Ecology and Food Production in West Africa, Hutchinson, London

SATC 1983, Seminar Report. Rainfed Rice-Fish Farming in Southern N.E.Thailand, Surin, November 9-11, 1983 (mimeo)

Samart, Mantana, 1985, 'Rapid Rural Appraisal: Experience at Khon Kaen University', in FA UKK

Schearer, S.Bruce, 1981, 'The Value of Focus Group Research for Social Action Programs', Studies in Family Planning, vol 12 no 12 pp 407-8

Shaner, W.W., P.F. Philipp and W.R.Schmehl, 1982, Farming Systems Research and Development: Guidelines for Developing Countries, Westview Press, Boulder (Co)

SIFP 1981, Studies in Family Planning, Special Issue: Focus Group Research, Studies in Family Planning vol 12 no 12, December, Part 1, pp 407-58

Simmonds, N.W. 1981, 'Genotypes (G), Environment (E) and GE components of crop yields', Experimental Agriculture, 17, pp 355-62

Willey, R.W., 1985, 'Evaluation and Presentation of Intercropping Advantages', Experimental Agriculture, 21, pp 119-33